function being to receive lymph on the one hand, and to propel it into the great vein of the tail on the other, but that, besides this function, it at the same time performs the secondary one of accelerating and promoting the flow of the blood in the great caudal vein in its course back to the blood-heart.

So far as the author has been able to ascertain, no one has hitherto given a correct explanation of the phenomenon of small drops of blood propelled in rapid succession, *as if* from the caudal heart, along the caudal vein. Without first showing that these small drops of red blood are *not* propelled *from* the caudal heart, and without showing that it is colourless lymph alone which is *really* propelled *therefrom*, no one could be warranted in dissenting from Dr. Marshall Hall, the discoverer of the caudal heart, in his opinion as to the nature of the organ, viz. that it is an auxiliary blood-heart, or in pronouncing it, how correctly soever, to be a lymphatic heart.

January 16, 1868.

Lieut.-General SABINE, President, in the Chair.

The following communication was read :—

Notices of some Parts of the Surface of the Moon, illustrated by Drawings. By JOHN PHILLIPS, M.A., D.C.L., F.R.S., F.G.S., Professor of Geology in the University of Oxford. Received January 9, 1868.

(Abstract.)

My first serious attempts to portray the aspect of the moon were made with the noblest instrument of modern times, the great telescope of Lord Rosse, in 1852. The mirror was not in adjustment, so that the axes of the incident and reflected pencils of light were inclined at a very sensible angle. This being met by a large reduction of the working area of the mirror, the performance was found to be excellent. I have never seen some parts of the moon so well as on that occasion. But when I came to represent what was seen, the difficulty of transferring from the blaze of the picture to the dimly lighted paper, on a high exposed station, with little power of arranging the drawing-apparatus, was found to be insuperable, and the effect was altogether disheartening. It was like setting down things *ex memoriâ*, to give the rude general meaning, not like an accurate and critical copy. I present as a specimen of this memorial a sketch of the great crater of Gassendi (No. 1).

I next mounted, in my garden at York, a small but fine telescope of Cooke only 2·4 inches in the aperture; and, aware of the nature of the difficulty which beset me at Birr Castle, I gave it an equatorial mounting, without, however, a clock movement. The whole was adapted to a large solid stone pillar in the open air. It was not possible, with $\frac{1}{60}$ of the light of the Rosse mirror, to *see* so well; but it was easy to represent far better what one saw, with a conveniently placed board to hold the draw-

ing-paper, a well-arranged light, and no necessity of changing position. I made in this manner the drawing of Gassendi which is marked No. 2.

My next attempt was made in the same situation with a fine telescope by Cooke, of $6\frac{1}{4}$-inch aperture and 11 feet sidereal focus, mounted equatorially, in the old English mode, and carried by clockwork. With this excellent arrangement I was enabled to use photography very successfully, and to obtain selenographs 2 inches across in 5^s of time. The drawing of Gassendi, No. 3, was made with this instrument (1853).

From these experiments the conclusion was obvious:—that for obtaining good drawings of the moon, convenient mounting was actually more important than great optical power; and that for such a purpose it was desirable to increase in every way the comfort of the observer, and furnish him with special arrangements for his own position and the placing of his drawing-board and light.

Having been called to reside in Oxford (1853-54), my plan for continual work on the moon was entirely cut through; it was impossible to mount a large instrument near my dwelling till (in 1860) the ground was arranged about the museum, so as to give me the requisite space and security close to the house which had been appointed for me by the University. I then arranged with Mr. Cooke for a new telescope of 6 inches aperture, to be protected in a well-planned observatory, the construction of which was aided by the Royal Society. I now propose to give a short notice of some of the results of my work with this instrument, in connexion with remarks on the most advisable course to be followed by other surveyors of the moon.

In making drawings of ring-mountains on different parts of the moon's disk, the artist will be much aided by a projection of the mountain-border on the scale intended, from a few measures, with its proper figure due to the latitude and longitude. Eye-drafts not thus controlled are apt to become absurd, by the heedless substitution of an ideal circle for a real ellipse. Thus I have seen Gassendi forgetfully represented by more than one skilful artist. Even with the advantage of such a projection (of which I give an example for Gassendi, No. 5) very considerable difficulties occur. One is the variation of outline caused by the displacement of the boundary of light and shade—first when the incidence of light varies through different angles of elevation of the sun, and next when the moon's position causes her to receive the light at the point observed on a different lunar azimuth. Even on so great a ring as Copernicus the variation of the outline as given by different artists is remarkable—hardly any one agreeing with what is really the most accurate drawing of all, that by P. Secchi; and that represents, not a simple ring, but a seven-angled outline. Dates must always be annexed to the figures; and as it is rarely possible to complete a good drawing of a large crater, except in two or three lunations or more, it becomes very essential that a bold free sketch be made of the moon's shadows to control the special work. (No. 6 is given as an example.)

Strictly speaking, there should be at least three drawings of a ring-mountain—in morning light, at midday, and in evening. It would be better to have five drawings, one at sunrise and another at sunset being added to the three already named. It will be found most convenient to make the drawings within two hours of the moon's meridian passage.

Shadows thrown from objects on the moon have exactly the same character as those observable on the earth. They are all margined by the penumbra due to the sun's diametral aspect; this is always traceable except very near to the object; but in consequence of the smaller diameter and more rapid curvature of the moon's surface, the penumbral space is narrower. At the boundary of light and shade, on a broad grey level tract, the penumbral space is about nine miles broad, quite undefined, of course, but perfectly sensible in the general effect, and worthy of special attention while endeavouring to trace the minute ridges (of gravel?) or smooth banks (of sand?), which make some of these surfaces resemble the postglacial plains of North Germany, or central Ireland, or the southern parts of the United States, which within a thousand centuries may have been deserted by the sea.

To the same cause is due the curious and transitory extension of half-lights over some portions of the interior of craters, while other neighbouring portions have the full light. The effect is occasionally to produce half-tints on particular portions of terraces within the crater, as in the case of Theophilus, of which I present two drawings, one showing this peculiarity in the morning light, the other not. The central mountains of that great crater are high enough to throw long shadows; and these, as they catch upon other peaks or spread, softening with distance, over the surrounding plains, present far greater variety of shadow-tones than might be expected on a globe deficient, as the moon really appears to be, of both air and water.

The different parts of the moon's surface reflect light very unequally; the dark parts have several degrees of darkness, the light parts several degrees of light. On the same level, as nearly as can be judged, under the same illumination, neighbouring parts are not only unequally reflective, but their light seems to be of different tints. Within the large area of Gassendi, under various angles of illumination, but more conspicuously when the angle of incidence deviates least from verticality, patches of the surface appear distinctly marked out by difference of tint, without shadow. It is well known that in this particular photography has disclosed curious and unexpected differences of the light, which were not apparent, or not so obvious, to the eye. Reflecting telescopes seem to be indicated as most suited for direct observation of differences of the kind of light on the moon.

The surface of the moon is hardly anywhere really smooth, hardly any where so smooth as may be supposed to be now the bed of a broad sea on our globe. By watching carefully the curved penumbral boundary of light and shade—as it passes over ridge and hollow, rift and plain,—broad swells,

minute puckerings, and small monticules appear and disappear in almost every part. In several of the *maria*, minute angular cup-craters about half a mile across are frequent; and on several of the exterior slopes of the crater-rings are seen pits, ridges, fissures, and rude craters, something like the sloping surfaces of Etna. Copernicus is a good example of this common occurrence. It appears extremely desirable that the details of this magnificent mountain should be carefully reexamined on the basis of Secchi's fine drawing, for the purpose, amongst others, of determining exactly how many of the bosses and ridges bear cup-hillocks; for many inequalities, which in feeble telescopes have but the indistinct character of being heaped up, appear distinctly crateriform with superior optical power *.

On the very crest of a ring-mountain it is rare to find a cup-crater; quite common to find them in the interior, especially towards the middle, and, in several cases, exactly central. But it happens often that the central mountain-mass of a large crater, such as Gassendi and Theophilus, is of a different structure. In the former a complicated digitated mass of elevated land appeared to me for a long time to be entirely devoid of any small craters; by continued scrutiny at last I see on one of the masses a distinct depression. The area in Gassendi reminded me of the volcanic region of Auvergne, in which, with many crater-formed mountains, occur also the Puy de Dome, Puy Sarcoui, Puy Chopin, and others which are heaps of a peculiar trachyte not excavated at the top, while the others are formed of ashes and lava-streams and are all crateriform. The central masses of Theophilus (Nos. 7, 8, and 9) are very lofty and grandly fissured from the the middle outwards, with long excurrent buttresses on one side, and many rival peaks separating deep hollows, and catching the light on their small apparently not excavated tops. This is like the upheaved volcanic region of Mont d'Or, with its radiating valleys, wide in the central part, and contracted to gorges toward the outside of the district.

The Vesuvian volcanic system, including the Phlegræan fields, exhibits, in all respects but magnitude, remarkable analogy with parts of the moon studded with craters of all magnitudes, as those adjoining Mount Maurolycus, engraved for comparison by Mr. Scrope in his admirable treatise on Volcanos (p. 232). It is probable that many of the differences which appear on comparing lunar ring-mountains may be understood as the effects of long elapsed time, degrading some craters before others were set up, and turning regular cones and cavities into confused luminous mounds. It would much augment our confidence in the possible history of the moon which these differences seem to indicate, if we could believe it to have ever been under the influence of atmospheric vicissitude as well as changes of interior pressure.

That the latter cause has been in great activity at some early period of the moon's history is not only evident, by the many sharply cut fis-

* See "Comparative Remarks on Gassendi and Copernicus," Roy. Soc. Proc. for 1856, p. 74.

sures which range like great faults in our earthly strata for five, ten' twenty, and sixty miles, but is conspicuously proved by the great broken ridges of mountains which, under the names of Alps, Apennines, and Riphæan chains, make themselves known as axes of upward movement, while so many of the craters near them speak of local depression. I have not been able to discover in these great ridges any such marks of successive stratification, or even such concatenation of the crests, as might suggest symmetrical and anticlinal axes. The surface is, indeed, as rough and irregularly broken as that of the Alps and Pyrenees, and marked by as extraordinary transverse rents, of which one, in the Alpine range near Plato, is a well-known example. Must we suppose these mountains to have undergone the same vicissitudes as the mountain-chains of our globe —great vertical displacement, many violent fractures, thousands of ages of rain and rivers, snow and glacial grinding? If so, where are the channels of rivers, the long sweeps of the valleys, the deltas, the sandbanks, the strata caused by such enormous waste? If the broad grey tracts were once seas, as analogy may lead us to expect, and we look upon the dried beds, ought we not to expect some further mark of the former residence of water there than the long narrow undulations to which attention has already been called as resembling the escars of Ireland?

In any further attempts of my own to contribute facts toward the survey of the moon, now again taken in hand by the British Association, I shall probably select for careful work some particular features, such as the mountains in the midst of a large crater, the bosses and cup-like hills on the outward slopes of such a crater, the rents in mountain-ridges, and the low winding banks which appear on the broad grey tracts. But, for those who desire to perform a work of high value, I would earnestly recommend a strict reexamination of every element in the great picture of Copernicus, for which we are indebted to the Roman Astronomer.

The paper was accompanied by twelve drawings, which were exhibited to the Society, and of which the following is a list:—

No. 1. Sketch of Gassendi taken in 1852, at Birr Castle, with the great telescope of Lord Rosse.

No. 2. Sketch taken in 1852, at York, with an achromatic by Cooke, of 2·4 inches aperture.

No. 3. Sketch taken in 1853, at York, with an achromatic by Cooke, of $6\frac{1}{4}$ inches aperture. (Morning.)

No. 4. Sketch taken in 1862, at Oxford, with an achromatic by Cooke, of 6 inches aperture. (Evening.)

No. 5. Working plan of Gassendi and scale.

No. 6. Free-hand sketches to illustrate the mode of working for general effect. Oxford, 1864.

No. 7. Theophilus, Cyrillus, and Catharina, taken at Oxford in 1862. This is about the third attempt.

No. 8. Theophilus, reexamined in 1863. This is the most complete drawing which I *can* make with my 6-inch. I intended to repeat the whole group.

No. 9. The central mountain-group of Theophilus on a large scale. 1863.

No. 10. Posidonius, early morning. 1863. (Unfinished.)

No. 11. Posidonius, nearer to midday. 1863. (Unfinished.)

No. 12. Aristarchus and Herodotus. This is about the sixth drawing, and exhibits in Aristarchus a double crater-wall, the inner one being sharp and interrupted; a deep narrow fissure separates the two walls. The interior surface is more moulded than in any drawings yet published. Herodotus, the dark crater, is merely sketched to give the course of the seeming valley which conducts from it to the seeming delta.

January 23, 1868.

Dr. WILLIAM B. CARPENTER, Vice-President, in the Chair.

The following communications were read:—

I. "Contributions towards determining the Weight of the Brain in the different Races of Man." By JOSEPH BARNARD DAVIS, M.D. &c. Communicated by Prof. JOHN MARSHALL. Received November 30, 1867.

(Abstract.)

It would naturally be expected that great attention had been directed to the human brain, the organ of mental manifestation. Still little has been done to ascertain its relative magnitude in the different races of mankind. Opportunities for examining exotic brains are rare, and it is only by gauging the internal capacities of human skulls, and deducing the weight of the brain, that data can be obtained.

The inferiority of this method is not so clear as has been assumed, since we are able to fix upon an unchangeable substance of definite specific gravity for the purpose of this gauging, whereby we compensate for the variable condition of the brain, depending upon disease and other causes, and the immediate occasion of death.

The great difficulty hitherto has been to decide upon a definite allowance, or scale of allowance for other matters besides brain which always fill up the cavity of the skull, in different proportions at different ages, &c. In the present investigations it has been considered most advisable to fix upon a definite, and at the same time proportionate, rule for compensating for these fluids and membranes. And, after much inquiry, that rule has been laid down as a general tare of 15 per cent. on the capacity af the skull.

In former inquiries of this kind by Prof. Tiedemann and Prof. Morton, this allowance has been entirely or almost entirely overlooked, by which means their extended observations really refer to the internal capacities of human skulls, and not to the weights of the brain, as they supposed. No